DOCUMENT RESUME

ED 024 208 24 EC 003 377

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Development of a Test for an Experimental Research Program in Creative Problem Solving. Final Report.

Southern Illinois Univ., Carbondale.
Spons Agency- Office of Education (DHEW), Washington, D.C. Bureau of Research.
Bureau No- BR-7-E-037
Pub Date Jul 68
Grant- OEG-3-7-700037-2940
Note- 66p.
EDRS Price MF-$0.50 HC-$3.40
Descriptors- *Cognitive Processes, Cognitive Tests, Creative Thinking, *Creativity, Divergent Thinking, Evaluation, *Exceptional Child Research, Item Analysis, Problem Solving, Productive Thinking, Test Construction, Testing, Test Interpretation, Test Reliability, Test Results, *Tests, Test Validity, Thought Processes
Identifiers- CDT, Creative Design Test

The purpose of this first phase of a continuing research program was the development of a test of creative problem solving in general design. A design class of 186 members was divided into an experimental and control group; a non-design control group (an educational psychology class) of 45 was also tested. Multivariate interpretation of creative problem solving was developed; five test problems were selected to make up the Creative Design Test (CDT); and solutions were judged for fluency, flexibility, and originality. An acceptable scoring and interproblem reliability was achieved on the instruction, library materials, and school pride problems, but not on the laundromat and paper product problems. No construct validity was obtained from teacher ratings of creativity in class or from a comparison of design and non-design students. Predicted relationships were not supported between performance on the CDT and the amount of problem-related knowledge possessed or whether systematic or non-systematic problem solving procedures were employed. Variations in variety and originality of prior solutions examined before the test made little difference to test performance. (Author/SN)

EDO 24208

BR 7-E-037
PA-24

FINAL REPORT
Project No. 7–E–037
Grant No. OEG–3–7–700037–2940

DEVELOPMENT OF A TEST FOR AN EXPERIMENTAL RESEARCH PROGRAM IN CREATIVE PROBLEM SOLVING

JULY 1968

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

OFFICE OF EDUCATION
BUREAU OF RESEARCH

ED03 3774

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Final Report

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Development of a Test For an Experimental Research Program In Creative Problem Solving

David T. Miles

Southern Illinois University

Carbondale, Illinois

July 1968

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking wuch projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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SUMMARY

This report describes the initial phase of a continuing research program dealing with creative behavior which involved the development of a test of creative problem solving.

The objectives of the research program are to collect more information about creative behavior and to apply this information to the production of educational materials and procedures. The objective of this study was to develop a test which could be used in the continuing research program.

A multivariate interpretation of creative problem solving which is to be employed in the research program is outlined. Definitions, assumptions, critical variables, and a research strategy are described.

Five test problems were selected according to several criteria for a test titled the Creative Design Test. Reliability and validity data were collected for the test, and an experiment was conducted using the test. Two variations of two prior solution examination variables were studies: high and low variety of prior solution and high and low originality of prior solution.

The major results were:

1. An acceptable scoring and interproblem reliability was achieved on three of the five problems.

2. No construct validity was obtained from teacher ratings of creative performance in class or from a comparison of design students (the students for whom the tests were designed) and a group of non-design students.

3. Meager evidence of construct validity was obtained from correlations with two of Torrance's tests and four of Guilford's tests.

4. No support was obtained for predicted relationships between performance on the Creative Design Test and (1) amount of problem-related knowledge possessed, and (2) whether systematic or non-systematic problem solving procedures were employed.

5. Variations in the variety and originality of prior solutions examined -- and whether or not prior solutions are examined -- was found to make little difference in performance on the CDT.

Subsequent research will involve (1) further attempts to obtain validity for the three more reliable problems; (2) determination of the relationships between CDT and several other tests; and (3) multivariate experiments with variables which have been shown to have a powerful influence on creative problem solving.

CHAPTER 1 INTRODUCTION

This research report describes the initial phase of a continuing investigation of creative behavior. In this first phase a test of creative problem solving was constructed and field-tested.

The major premise upon which this research program was initiated was the desirability of more continuing, systematic research programs dealing with creativity. The work of Guilford (1962), Torrance (1964), Parnes (1960), Mednick (1962), and Maltzman (1960) gives evidence of the value of such research programs, and the importance of creativity as an area of study is well established both from a theoretical frame of reference and for the practical purpose of developing ways of shaping and maintaining creative performance.

The general objectives of this continuing research program are (1) to systematically collect, organize, and communicate information regarding the explanation, prediction, and control of creative problem solving behavior, and (2) to design, develop, and field-test instructional materials (programed instruction, handbooks, practice exercise units, etc.) applying the findings from this and other research programs.

The first effort in this research program, which is reported here, was the development of a test of creative problem solving. Although several creativity tests already existed, it was considered desirable to develop a reliable and valid test which is consistent with the research program within which it is to be used. Following are the definitions, assumptions, relevant variables, and the research strategy for this research program.

Research Program

A Definition of Creative Problem Solving

1. A problem is a situation in which a person is required to make a response to achieve a particular goal by making a response which he has not previously made and which he has not previously experienced being made.

2. Problem solving is the behavior, both observable and non-observable (thinking), which a person engages in to produce a response which solves a problem.

3. A solution to a problem is a response which achieves the particular goal which was required for the problem to be considered solved.

4. Thus, a solution which solves a problem must be an original solution for the problem solver since he has not made it previously.

5. Creative problem solving is distinguished from general problem solving in two ways: (a) in creative problem solving there are several possible solutions to a problem, while in general problem solving only one solution is possible; and (b) in creative problem solving two criteria are used to judge solutions: (1) whether the solution solves the problem, and (2) the degree of originality of the solution. With general problem solving only the criterion of solution success is used.

6. The degree of originality of a particular solution is based on the extent to which the solution differs from solutions to the same problem produced by other people. If it differs from most of the other solutions, it is considered more highly original than if it is similar to other solutions. However, if each of the other solutions with which a particular solution is compared is quite different from all other solutions, then all solutions must be considered equally original and thus a relative degree of originality does not exist. Thus, there must be some similarity among some of the other solutions to obtain a relative scale of originality.

7. The number of other solutions with which a particular solution is compared influences the degree of originality associated with a solution as well as the confidence placed in an originality assessment. If the solution is found to be different from 100 other solutions, then it can be considered more original than if it is compared with and found different from only 10 other solutions.

8. The qualitative characteristics of the people producing the other solutions also affect the validity of an originality assessment. A toy design judged to be original when compared with a group of professional toy designers would be considered a more valid estimate of originality than if the comparison was with the toy designs of a group of college freshmen English majors.

Some Assumptions about the Nature of Creative Problem Solving

Creative problem solving ability is:

1. determined by genetic endowment and by experience.

2. possessed by everyone to a greater or lesser degree.

3. modifiable through typical behavior control techniques (reinforcement, practice, extinction, etc.).

4. expressed in almost all occupations and activities (art, science, housekeeping, teaching, etc.).

5. a stable enough trait to render it subject to measurement with traditional psychometric procedures.

6. different from what is measured by intelligence tests (i.e., knowledge recall plus application, analysis, and evaluation skills) primarily due to the emphasis on skills of transfer and synthesis in addition to the knowledge and skills measured by intelligence tests.

Independent Variables Which Influence Creative Problem Solving

Since there is comparatively little empirically-derived information regarding creative problem solving, it is considered premature to attempt to construct elaborate mathematical theories to organize and relate the facts. Nevertheless, some means for guiding the systematic collection of data is needed. Following is a specification of variables which are thought to influence creative performance. Some of the variables have been found to influence creativity (although the reliability of such findings is often questionable) while others lack empirical support.

The way the list is interpreted is that differences in creative problem solving performance are to some extent a function of each of the variables on the list. In other words, each of the variables accounts for a significant portion of the variance in creative problem solving. Thus, given quantitative knowledge of all these variables for a group of subjects and a regression equation with valid weights for each variable, it should be possible to predict with considerable accuracy the creative performance of the individuals in the group. This multivariate approach is based on the multiple linear regression analysis procedures of Kelly, et al. (in press) and Bottenberg and Ward (1963). Another similar approach is Hinton's (1968) recent model for studying creative problem solving.

Creative Problem Solving Variables

I. Pre-Problem Experience Variables:

   A. Experiences with long-term effects (reinforced practice with brainstorming, training in visualization, synectics training, etc.)

   B. Experiences with short-term effects (examining prior solutions, remote association training, etc.)

II. Problem-Solver Variables: relatively stable characteristics of individuals.

   A. Knowledge and skills

      1. General (I.Q., aptitudes, critical thinking ability, short-term memory, etc.)

2. Specific -- related to problem (physics knowledge for physics problems, skill in solving problems requiring hueristic methods, etc.)

B. Attitudes -- toward a specific problem, problem solving in general.

C. Motivation -- for solving a specific problem, for solving problems in general.

D. Personality (self-confidence, tolerance for ambiguity, autonomy, etc.)

E. Sex

III. Problem Solving Context:

A. Physical context (time allotted, materials available, visual and auditory distraction, temperature, testlike versus non-testlike conditions, information-gathering potential, opportunity to test possible solutions)

B. Psychological context -- incentive for solving (to achieve personal goal, money, course requirement)

IV. Problem Solving Procedure Variables:

A. Non-systematic (random association, etc.)

B. Systematic (inductive, attribute listing, synectics, morphological analysis, etc.)

V. Problem Variables:

A. Subject matter

1. General (unusual uses, anagrams, remote associates test, Maier two-string problem, etc.)

2. Specific (Owen's creative machine design tests, Hyman's test for engineers, economic problems, problems in biology, etc.)

B. Problem presentation (instructions, problem definition, written versus actual, experimenter)

C. Form of response required (written, oral, construction, performance, illustration)

D. Number of possible solutions (one = general problem solving; two or more = creative problem solving)

E. Criteria for success (functional effectiveness, originality).

A visual model of the five classes of variables is shown in Figure 1.

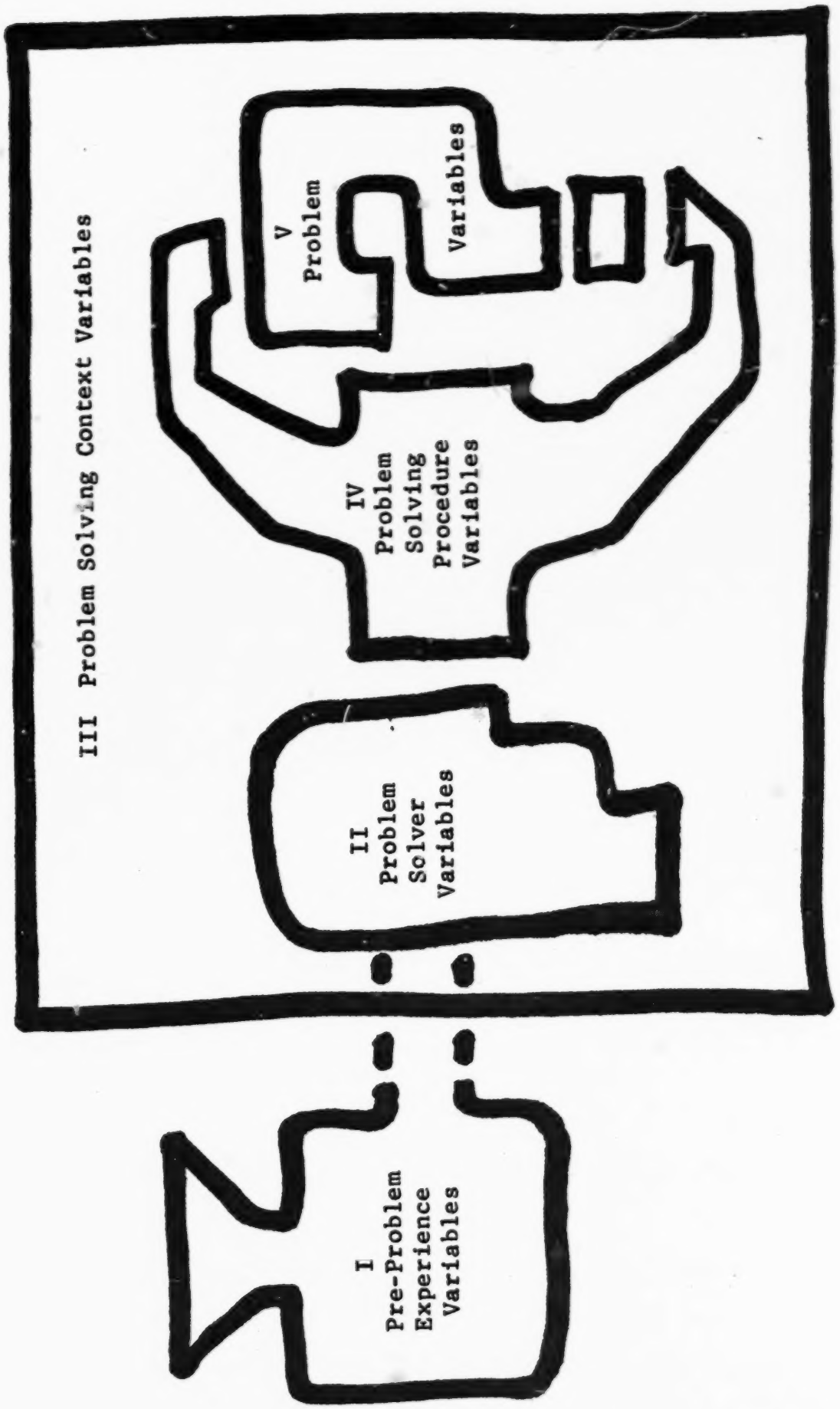

Figure 1. Five Classes of Variables in Creative Problem Solving

For most of these variables it is known, or strongly suspected, that the variable has some influence on some types of creative performance. For example, students with high critical thinking ability are typically better problem solvers than students with low critical thinking ability; students who use brainstorming techniques will tend to produce more original solutions than students not using brainstorming; and non-testlike conditions may be more conducive to creativity than testlike conditions. But the kind of information which is not known is whether the use of brainstorming has a constant facilitative effect on students of varying degrees of critical thinking ability (or with varying degrees of motivation, or knowledge about the task, etc.) under both testlike and non-testlike conditions.

Rather than holding constant all variables except one -- say, whether brainstorming was or was not used -- the approach here is to obtain values for each relevant variable and to determine whether the differences between groups attributable to the brainstorming versus non-brainstorming treatment accounts for a significant portion of the variance in problem solving over and above the portion of variance accounted for by the other variables.

Research Strategy

The basic research strategy to be followed is one of (1) selecting, and/or developing and refining valid and reliable descriptive measures of each of the independent variables (e.g., critical thinking, motivation, physical context, problem solving process, etc.); (2) collecting data on the relationship among the independent variables and valid and reliable measures of creative problem solving; and (3) eventually obtaining weights for each independent variable which will permit highly reliable prediction and control of creative performance.

Test Development

As previously mentioned, the first phase of this research program required the development of a test for use in exploring the parameters of the previously described variables. The reason that existing tests such as Guilford's or Torrance's were not used is that these tests lack external validity, i.e., they are frequently unlike any common problem solving situation due to their brevity, testlike characteristics, artificiality, and lack of occupational or subject matter specificity. Thus, it was determined that a set of criteria should be developed to insure that similar deficiencies in external validity would be avoided in the new test.

The first decision regarding the test was the selection of an occupational subject area for the test. General design as taught by the Department of Design at S.I.U. was selected as the subject area because

(1) creative problem solving is the primary educational objective of the program; (2) the subject matter domain is quite broad (e.g., city planning, systems analysis, graphic design, product design); and (3) the experimenter was familiar with the objectives and curriculum of the program. The details of the test development are described in the next two chapters.

Field Test Experiment

As part of the first phase of the research program, an experiment was conducted to operationally test the newly developed creativity instrument. The variable chosen to investigate was in the "short-term, pre-problem experience" category: examining prior solutions. One dimension of this variable -- positive versus negative evaluation of prior solutions -- has been explored and the general findings are that positive evaluation is superior to negative (Hyman, 1961; Torrance, 1964). Hyman (1961, 1964) has also investigated the variety of prior solutions examined and obtained mixed effects, and the commonness of prior solutions and found no effects. But in neither experiment was the variety and originality of prior solutions manipulated at the same time. In an attempt to provide further knowledge regarding these variables, an experiment was conducted in which all subjects employed constructive evaluation (since it has generally been found to be superior to negative evaluation) and to manipulate only the variety and originality (commonness) of prior solutions. The experiment required four experimental groups, one for each extreme variation of the two variables: (1) high variety, high originality; (2) high variety, low originality; (3) low variety, low originality; and (4) low variety, high originality.

In addition to manipulating these variables, data were collected from a sample of subjects used in the test development phase regarding the relationship between their creative problem solving performance, their problem-related knowledge, and their problem solving process used in solving problems.

The procedures followed in the experiment are described in the next chapter.

Research Questions

The specific research questions which this study was designed to answer are as follows:

1. Scoring Reliability. How reliable is the scoring procedure for the Creative Design Test (CDT) (the test developed in this study)?

2. Interproblem Reliability. What is the relationship among the problems on the CDT?

3. Intercriterion Relationship. What is the relationship among the CDT criteria: fluency, felxibility, originality?

4. Construct Validity. What is the relationship between subjects' CDT scores and the average of three design instructors' ratings of the subjects on creative design performance in design courses?

5. Construct Validity. To what extent does the CDT measure similar characteristics as two of Torrance's tests and four of Guilford's tests?

6. Construct Validity. Do design majors do better on the CDT than students majoring in another field in which little or no emphasis is placed on creative problem solving?

7. Theory Testing. What is the relationship between the CDT and (1) the amount of problem-related knowledge possessed; (2) the degree of knowledge possessed regarding the criteria for solutions' originality; and (3) the use of a systematic versus a non-systematic problem solving process?

8. Experimental Treatment Effects.. Does examining prior solutions of differing degrees of originality and variety influence performance on the CDT?

CHAPTER 2 METHOD

Test Development

The first step in developing problems for the Creative Design Test was to establish the following eleven criteria to serve as a guide in selecting problems.

Criteria for Problem Selection

1. Scoring Criteria: (Construct validity) The problem must have two scoring criteria: (1) an effectiveness dimension; and (2) a creativity dimension, i.e., originality, fluency, and/or flexibility. The scoring procedure must achieve .90 or better intra- and inter-scorer reliability.

2. Occupational Relevance: (External validity) The problems must be similar to problems performed in a particular discipline (industrial design) so that subjects will be able to draw on previous experiences and training to solve the problem. The problems should involve matters related to the University -- the current environment of the subjects. (External validity -- subjects' performance on the experimental problems should be similar to their performance on actual design problems.)

3. Realism: (External validity) The problems must closely approximate actual problems solved by the subjects in their occupation.

4. Variety of Solutions: (Construct validity) Each problem must have a variety of possible solutions.

5. Problem Solving Time: (External validity) Adequate time must be provided for each subject to solve the problems to his own satisfaction. The problems must be long enough to avoid sampling spontaneous response tendencies, but not so long as to be impractical as part of an experimental battery of tests. Roughly something between 15 minutes and four hours.

6. Problem Solving Context: (External validity) The conditions under which the problems are solved should be something other than typical classroom testing conditions. The subjects should be individually isolated, but permitted to take breaks, smoke, drink coffee, etc., as they desire.

7. Resource Materials: (Experimental control) All materials and information to be used in performing the problems must be provided. Subjects should not be permitted to bring in other materials or equipment or to seek out information not provided.

8. Pre-Problem Solving Manipulation: Problems must offer the possibility for exposing subjects to pre-problem solving treatments, for example, examining prior solutions or studying the criteria for success.

9. Reliability: The problems should have at least moderate reliability -- low-to-moderate positive correlation among the various problems.

10. Concept versus Product: (Construct validity) The concepts or ideas which subjects produce should be given prime consideration in evaluation as opposed to the form (neatness, presentation elegance, literary form, drawing, or construction quality) of the subjects' solutions.

11. Problem Variety: (Content validity) The problems selected for the test should sample a variety of response modes (writing, drawing, model building) and a variety of types of problems (book cover design, student room design, design of a campus communication system, development of a commencement exercise plan).

Employing the above criteria, fourteen problems were developed; and from these five were selected for use in the Creative Design Test. Copies of the selected problems follow on the next pages.

PAPER PRODUCT

The S.I.U. Student Government has developed a plan for conducting a series of teacher-student seminars dealing with critical issues on the local, national, and international levels. However, to carry out this plan, funds are needed for renting auditoriums, advertising, refreshments, printing programs, and so on. Your task is to help raise some money for this purpose by designing ten marketable items to sell to S.I.U. students. Fortunately, the Student Government has a large supply of paper, 8½" x 11" sheets of white, blank, mimeograph paper from which you are to make your products. Your only restriction is that the available paper must be the principle material used in each product.

Your ideas for paper products will be judged on three criteria:

1. Variety: Your ten products should be as varied as possible; in other words, each product should be as different from each other product as possible.

2. Originality: Each of your products should be unlike any products other S.I.U. design students would design.

3. Sales Potential: Each of your ten products should appeal to S.I.U. students; that is, each product should be something that S.I.U. students would be likely to buy.

You should provide a short verbal description of each product and a rough sketch when appropriate.

There is no time limit; however, you should be able to come up with ten products in about one hour.

SCHOOL PRIDE

Problem: It has recently come to the attention of the S.I.U. administration that both the students and the faculty at S.I.U. possess very little pride in their institution. This condition is considered to have a negative influence on the general quality of education at S.I.U.

Your task is to suggest ten different plans to strengthen the pride of both faculty and students in S.I.U.

Your plans will be judged on three criteria:

1. The potential effectiveness of each of your plans, that is, whether the plan offers a reasonable possibility of increasing student and faculty pride.

2. The variety of your ten plans. Each plan should be as different from the others as possible.

3. The originality of each plan. Each plan should be as different from those produced by other S.I.U. design students as possible.

A short verbal description of each of your plans should be sufficient. Number each of your plans. There is no time limit; however, you should be able to produce ten plans in about one hour.

INSTRUCTION TIME

Problem: It has come to the attention of the S.I.U. administration that a considerable amount of valuable instruction time is lost each day by faculty and students in getting to and from classrooms, offices, and dormitories. Your task is to suggest as many original ways as you can to solve this problem.

Your ideas will be judged on these criteria:

1. The total number of ideas you produce. The more the better.

2. The variety of the ideas you produce. The more different types of ideas you produce the better.

3. The originality of each of your ideas, that is, how unusual or rare each of your ideas is as compared to ideas produced by other S.I.U. design students.

4. Each of your ideas must be a feasible solution to the problem.

A short verbal description for each idea will be sufficient. Number each idea. There is no time limit; however, you should be able to exhaust your supply of ideas in about one hour.

LAUNDROMAT

This is a test of your ability to think of creative ways to increase the amount of business done by a self-service laundry in Carbondale.

Your task is to list all of the different ways you can think of to influence S.I.U. students to use "Edward's Laundromat" rather than a number of other available self-service laundries.

The Edward's Laundromat is in a building that has a 40' x 50' floor space. There are 20 washers, 10 dryers, a row of tables for folding clothes, some carts for use in taking clothes out of the dryers, an automatic money changer, a soap vending machine, a sink, a pay telephone, vending machines for drinks, candy, and cigarettes, and several chairs.

You may spend up to $5000 for any one of your plans.

You are free to try anything to get students to do their laundry at Edward's <u>except</u> the following:

1. Move the building (and you must assume that Edward's is located the same distance from the campus as the other self-service laundries in Carbondale).

2. Make major architectural changes in the building.

3. Change the amount of money required by the washers and dryers.

Your ideas will be judged on three criteria:

1. The <u>total number</u> of different ideas you produce. The more the better.

2. The <u>originality</u> of each of your ideas, that is, the more unusual or rare each of your ideas is as compared to ideas produced by other S.I.U. design students, the better.

3. The <u>variety</u> of your ideas. The more different types of ideas you produce the better.

4. The <u>feasibility</u> of each of your ideas, that is, whether the ideas could actually be implemented and whether there is some reasonable promise of the idea resulting in an increase in business.

A short verbal description for each plan will be sufficient. Number each idea. There is no time limit; however, you should be able to exhaust your ideas in about one hour.

LIBRARY MATERIALS

Problem: The periodicals and reference materials in the Morris Library are constantly being marked up and having pages torn out; and volumes are being stolen. Replacing these materials is extremely costly, and a plan is needed to eliminate -- or at least reduce -- this problem.

Your task is to think of several different solutions to this problem.

Your solutions will be judged on four criteria:

1. The total number of different solutions you produce. The more the better.

2. The originality of each of your solutions, that is, the more novel each of your solutions is as compared to solutions produced by other S.I.U. design students, the better.

3. The variety of your solutions. The more different types of solutions the better.

4. The effectiveness of each of your solutions. The more effective your solution is in reducing the damage and theft problems while providing efficient periodical and reference material service, the better. Your solutions will also be evaluated for cost and technical practicality. The less a solution costs and the more technically reasible a solution is, the better.

A short verbal description of your solutions will be adequate. Number each solution.

There is no time limit; however, you should be able to exhaust your solutions in about one hour.

Test Scoring

The first step in scoring the solutions was to determine whether each solution was a plausible (i.e., technically or logically feasible) solution to the problem. The unplausible ones were eliminated.

The three creativity criteria were scored in the typical manner -- fluency = the total number of solutions produced; flexibility = the number of different categories in which solutions were produced; and originality = each solution's statistical infrequency based on all the solutions produced by the group (weights are 9 points for unique solutions, 8 points for solutions which two students had produced, and so on down to 0 points for solutions which ten or more students produced). Four measures of originality were tried: the high weight, the average of the three highest weights, the average of the five highest weights, and the average of all weights. The five highest average was selected as it appeared to offer the most reliable and representative index of originality for most subjects, i.e., the majority of subjects produced about five solutions which received originality scores of one or more and the remainder of their solutions received zero scores.

Another step in scoring solutions was to eliminate any solutions which duplicated any of the prior solutions which the subjects examined prior to producing solutions.

Although originality is considered the basic criterion (in addition to solution success) of creative problem solving according to the definitions in Chapter 1, the two other criteria, fluency and flexibility, which are frequently associated with creative behavior, were also explored in this study.

Test Data Collection

To obtain reliability and validity data (research questions 1 through 6), half of the students majoring in design at Southern Illinois University (N=93) were invited to take the tests and were offered $2 per hour to complete the six- to seven-hour testing battery. Forty-one students started the battery; however, only 25 completed all instruments, which, in addition to the Creative Design Test, included (1) two of Torrance's tests: Product Improvement and Picture Completion; (2) four of Guilford's tests: Associational Fluency, Consequences, Pertinent Questions, and Alternate Uses; (3) a form to obtain an estimate of the amount of problem-related knowledge each student possessed for each problem (shown in Appendix A); (4) a form to obtain the degree of knowledge each student possessed regarding the criteria for solution originality for each problem (Appendix B); and (5) a form for students to indicate whether they used a systematic or non-systematic problem solving procedure in solving each problem (Appendix C). The order in which the tests and forms were completed was the same as that above.

The tests and forms were completed at desks and tables in the foyer outside the experimenter's office. The students were tested individually, and completed the testing in varying schedules from one-hour blocks over three weeks' time to three-hour blocks in two days.

Three design instructors who had taught most of the students in the Department of Design were selected to rate the students' creative design performance in design courses. The instructions and forms used to record the ratings are in Appendix D.

The non-design student group (research question Number 6) was composed of 45 students enrolled in two introductory educational psychology classes. They were selected and tested in the same manner as were the design students.

Experiment

The other half of the students majoring in design (those not used in the preceding phase of the study) were invited to participate in the experiment (N=93). Sixty-two students began the testing, but only 31 completed all tests.

The testing procedure and conditions for this group were identical to those employed with the preceding group, except that prior to solving the Creative Design Test problems, the experimental subjects read and responded to ten prior solutions. There were four variations of prior solutions, one of which was employed for each of four randomly assigned groups. The prior solution variations were:

Group 1. High variety - high originality

Group 2. High variety - low originality

Group 3. Low variety - low originality

Group 4. Low variety - high originality

The prior solutions were obtained from design students who had completed the problems in a pilot phase of the project, and the originality classification was based on the weights obtained for the group used in the test validation. An example of the prior solution forms is contained in Appendix E.

The data were collected during the spring quarter and several attempts were required to induce students to complete the battery.

CHAPTER 3 RESULTS

In this chapter each research question stated in Chapter 1 is restated and followed by an hypothesis (when relevant), the question stated in statistical terms, the analysis performed to answer the question, the results, and a brief interpretation of the results.

Research Question No. 1 - Scoring Reliability:

How reliable is the scoring procedure for the Creative Design Test?

Hypothesis: none stated.

Statistical Question: How many discrepancies in categorization are there between (1) the same scorer's categorization of the same solutions twice, and (2) two different scorers' categorizations of the same solutions?

Analysis: A count of the number of discrepancies in categorization of a sample of solutions, within and between scorers. Also correlations on some of the data.

Results: After several revisions and refinements of the originality and flexibility categories, two scorers were able to independently categorize approximately 94 of 100 solutions into the same categories for the Instruction Time, Laundromat, and Library Materials problems. A discrepancy in inter-scorer categorization of approximately 11 of 100 solutions was obtained on the School Pride problem and 19 of 100 for the Paper Product problem. In all categorization discrepancies, the conflict could be resolved and each solution categorized into one category. Thus, the differences between scorers were a matter of errors in judgment by the scorers and not a function of overlapping categories. It appeared that with more extensive scorer training, a higher level of inter-scorer reliability could be achieved.

It should be noted that discrepancies in assigning solutions to categories had no effect on the fluency criterion score and a fairly minor influence on the flexibility and originality criteria scores. For example, with ten category discrepancies on the School Pride problem, there were only two cases in which the flexibility score was affected, and for those two the difference was only one point. Similarly, for the originality criterion of the School Pride problem, with 11 discrepancies of 100 solutions, the intra-scorer r was .84. An intra-scorer reliability check with the Library Materials test turned up a 4 per cent categorization discrepancy, but identical originality scores for an r of 1.00.

Interpretation:

The scoring reliability for three of the problems: Instruction Time, Laundromat, and Library Materials, is considered adequate while further refinements in scoring the Paper Product and School Pride problems appear desirable.

Research Question No. 2 - Interproblem Reliability:

What is the relationship among the Creative Design Test problems?

Hypothesis: There will be a statistically significant positive relationship between performance on each criterion among the five test problems.

Statistical Question: What is the correlation between the five problems for each of the three criteria?

Analysis: Correlation.

Results: The statistically significant correlations between problems for each criterion are shown in Table 1.

Table 1

Statistically Significant Correlations
Between Problems on the Three Criteria

Fluency				
Problems		N	r	Sig.
Instruction Time	Laundromat	63	.67	.005
Instruction Time	Library Materials	60	.76	.005
Laundromat	Library Materials	61	.65	.005
Flexibility				
Problems		N	r	Sig.
Instruction Time	Laundromat	63	.44	.005
Instruction Time	Library Materials	60	.35	.005
Originality				
Problems		N	r	Sig.
Instruction Time	Laundromat	64	.31	.01
Instruction Time	Library Materials	55	.37	.005
Laundromat	Library Materials	56	.36	.005

For most of the criteria subjects performed similarly, in relation to each other, on the Instruction Time, Laundromat, and Library Materials problems. There was little or no relationship between performance on the Paper Product problem and the other four problems or between the School Pride problem and the other four problems.

Interpretation:

It appears that three of the problems: Instruction Time, Laundromat, and Library Materials, provide similar measures of the three criteria: fluency, flexibility, and originality. Performance on the Paper Product and School Pride problems apparently is unrelated to each other and to the other three tests. Perhaps what makes the Paper Product problem different from the others is that it is less of a "real" problem and more of an exercise. The School Pride problem, on the other hand, may differ from the other in that the problem is less concrete, and, as a result, the criteria for success are more difficult to specify.

Research Question No. 3 - Intercriterion Relationship:

What is the relationship among the Creative Design Test criteria: fluency, flexibility, and originality?

Hypothesis: There will be statistically significant correlations between the criteria for each problem and for the total test.

Statistical Question: What is the correlation between the criteria for each problem and on the total test?

Analysis: Correlation.

Results: The correlations between criteria for each problem and the total tests are shown in Table 2 and Table 3, respectively.

Table 2

Correlations between Criteria for Each Creative Design Test Problem

Problem	Criteria		N	r	Sig.
Paper Product	Flexibility	Originality	103	.35	.005
School Pride	Flexibility	Originality	94	-.12	----
Instruction Time	Fluency	Flexibility	70	.63	.005
	Fluency	Originality	69	.63	.005
	Flexibility	Originality	69	.42	.005
Laundromat	Fluency	Flexibility	65	.54	.005
	Fluency	Originality	63	.54	.005
	Flexibility	Originality	63	.16	----
Library Materials	Fluency	Flexibility	61	.56	.005
	Fluency	Originality	56	.72	.005
	Flexibility	Originality	56	.57	.005

Statistically significant relationships were found between fluency and originality and between fluency and flexibility for all three tests in which fluency was a criterion. Such relationships were also obtained for flexibility and originality for the Paper Product, Instruction Time, and Library Materials problems but not for the School Pride and Laundromat problems.

Table 3

Correlations between Criteria Totals for Creative Design Test

Criteria		N	r	Sig.
fluency	flexibility	59	.55	.005
fluency	originality	59	.60	.005
flexibility	originality	58	.49	.005

The correlations between criteria for the total Creative Design Test were all significant.

Interpretation:

The criteria of fluency, flexibility, and originality apparently provide similar measures of performance on the Creative Design Test.

Research Question No. 4 - Construct Validity (Instructors' Ratings):

What is the relationship between students' scores on the Creative Design Test and the average of three design instructors' ratings of the students on creative design performance in design courses?

Hypothesis: There will be positive and significant correlation between the Creative Design Test scores and the creative design performance ratings.

Statistical Question: What is the correlation between the criteria scores on the Creative Design Test and the instructors' creative design performance ratings?

Analysis: Correlations between scores and ratings.

Results: The intercorrelations between the three design instructors' ratings were .18, .25, and .32, which suggests that instructors were not in close agreement regarding the creative design performance of their students. The correlations between ratings and scores are shown in Table 4.

Table 4

Correlations between Design Instructors' Ratings
Of Creative Design Performance and Scores on the Creative Design Test

Design Inst. Ratings	Problem	Criterion	N	r	Sig.
Ratings	Paper Product	Flexibility	51	.07	----
		Originality	51	.17	----
Ratings	School Pride	Flexibility	45	.044	----
		Originality	45	.26	----
Ratings	Instruction Time	Fluency	40	.28	----
		Flexibility	40	.28	----
		Originality	39	.32	.05
Ratings	Laundromat	Fluency	37	.13	----
		Flexibility	37	.01	----
		Originality	37	-.08	----
Ratings	Library Materials	Fluency	35	.06	----
		Flexibility	35	.10	----
		Originality	33	.14	----
Ratings	Total CDT	Fluency	59	.08	----
Ratings	Total CDT	Flexibility	58	.23	----
Ratings	Total CDT	Originality	60	.26	.02

Except for the criteria on the Instruction Time problem and the originality criteria for the total Creative Design Test, there were no significant relationships between design instructors' ratings and performance on the Creative Design Test.

Interpretation:

Since the Creative Design Test problems are similar to those used in the design education program from which the students and instructors were selected, the reason for the lack of agreement between the ratings and Creative Design Test scores may be in the different criteria employed to evaluate problem solutions. The criteria of fluency and flexibility are rarely, if ever, used in evaluating student performance in the design education program, and although the originality of students' solutions is frequently evaluated, it is typically considered of less significance than the functional effectiveness of solutions. Thus, the different emphasis in evaluation between the test and the classroom could be the reason for the lack of relationship found between them.

It seems feasible that greater effort to train the raters to rate students predominantly on the creativity criteria (perhaps only originality rather than all three) would improve their inter-rater reliability and, as a result, also increase the validity estimate.

Research Question No. 5 - Construct Validity (other creativity tests):

To what extent does the Creative Design Test measure similar characteristics (fluency, flexibility, and originality) as two of Torrance's tests, Product Improvement (fluency, flexibility, and originality) and Picture Completion (fluency, flexibility, and originality), and four of Guilford's tests, Associational Fluency, Alternate Uses (semantic spontaneous flexibility), Consequences (ideational fluency and originality), and Pertinent Questions (conceptual foresight)?

Hypothesis: There will be a low positive correlation between related criteria on the tests.

Statistical Question: What is the correlation between the Creative Design Test problem criteria scores and the related factor scores on Torrance's and Guilford's tests?

Analysis: Correlation.

Results: The statistically significant correlations and correlations above .20 are reported in Table 5.

Table 5

Correlations of .20 and Above between Creative Design Test Scores And Scores on Other Creativity Tests (N=44)

CDT Criterion	Other Test	r	Sig.
Paper Product Problem			
Flexibility	Product Improvement Flexibility	.36	.01
Flexibility	Picture Completion Flexibility	.21	----
Flexibility	Alternate Uses	.20	----
Flexibility	Pertinent Questions	.30	.02
School Pride Problem			
Flexibility	Product Improvement Flexibility	-.20	----
Originality	Product Improvement Originality	.42	.005
Originality	Pertinent Questions	.20	----
Instruction Time Problem			
Fluency	Product Improvement Fluency	.30	.02
Fluency	Associational Fluency	-.31	.02
Fluency	Picture Completion Fluency	.28	----

	Laundromat Problem		
Fluency	Product Improvement Fluency	.30	.02
Fluency	Associational Fluency	-.20	----
Fluency	Picture Completion Fluency	.31	.02
Originality	Consequences Remote	.36	.02
Originality	Pertinent Questions	.33	.02
	Library Materials Problem		
Fluency	Product Improvement Fluency	.38	.005
Fluency	Associational Fluency	-.37	.01
Fluency	Picture Completion Fluency	.31	.02
Flexibility	Picture Completion Flexibility	.21	----
Originality	Pertinent Questions	.31	.02
	Creative Design Test Criteria Totals		
Fluency	Product Improvement Fluency	.28	----
Fluency	Associational Fluency	-.31	.02
Fluency	Picture Completion Fluency	.32	.02
Originality	Product Improvement Originality	.22	----
Originality	Consequences Remote	.26	----
Originality	Pertinent Questions	.48	.005

Interpretation:

Four tests appear to have the most consistent relationship with the Creative Design Test criteria: Pertinent Questions with originality, Picture Completion fluency with fluency, Associational Fluency (negatively) with fluency, and Product Improvement fluency with fluency. The Creative Design Test flexibility criterion appears to have the least in common with the other tests of flexibility.

The negative relationship between Associational Fluency and Creative Design Test fluency was unexpected and the only interpretation which suggests itself is that the Associational Fluency test is more a test of verbal skill and the CDT is more a test of non-verbal conceptual skill. Thus, design students who are better at conceptual problem solving tend to have poorer verbal skills, and students with less effective conceptual problem solving skills tend to have better verbal skills. This condition could have occurred through reinforcement of successful problem solving strategies and extinction of unsuccessful strategies.

The above relationships, particularly the first, third, fourth, fifth, and sixth in the Creative Design Test totals, are interpreted as providing some evidence that the Creative Design Test measures similar

characteristics (fluency and originality) as other tests and, therefore, is to some degree a valid measure of these characteristics.

It should be noted that the Pertinent Questions test is not typically considered a measure of creativity or divergent thinking. It does, however, appear to measure an ability which is highly related to creative problem solving, namely "conceptual foresight" which is defined as "the ability to be aware of implications in given information," and it is scored in the same manner as measures of fluency. Thus, its use for exploring what might be termed the more intellectual dimension of creativity appears warranted.

Research Question No. 6 - Construct Validity (college major):

Do design majors do better on the Creative Design Tests than students majoring in another field in which little or no instruction and practice is provided in creative problem solving?

Hypothesis: Design majors will score significantly higher than other majors:

Statistical Question: Is there a statistically significant difference between design majors and other majors on each of the individual test scores?

Analysis: Multiple linear regression analysis: Full model - weights for each group used vs. Restricted model = one weight for both groups. (This analysis produces an F-ratio identical to that produced with an analysis of variance and was used instead of the analysis of variance due to the availability of multiple linear regression computer programs.) The freshman design majors were eliminated from the analysis since they were not considered as representative of design majors as upperclassmen due to their limited exposure to the design education program.

Results: The means and standard deviations are shown in Table 6. The only statistically significant difference found was on the flexibility criterion for the Instruction Time problem. The non-majors scored significantly higher than the design majors, $F = 7.81$, $p < .007$. Two other comparisons approached statistical significance; design majors were superior on Instruction Time fluency, $F = 3.24$, $p < .08$, and also on Library Materials originality, $F = 3.27$, $p < .07$.

Table 6

Ns, Means, and Standard Deviations for Non-Design Majors (N=44) And Design Majors (N=59) on Three Creative Design Test Problems

Test	Criterion	Non-Design Majors $\bar{X}$	SD	Design Majors $\bar{X}$	SD
Instruction Time	Fluency	8.39	3.57	9.68	4.69
	Flexibility	4.89	1.81	3.49	.98
	Originality	6.06	2.43	5.36	2.48
Laundromat	Fluency	12.87	5.30	12.66	6.53
	Flexibility	4.58	1.15	4.39	1.03
	Originality	6.73	1.94	6.00	2.37
Library Materials	Fluency	7.18	2.31	7.95	4.25
	Flexibility	4.62	1.55	5.46	2.69
	Originality	2.89	1.70	3.51	2.26

Interpretation:

Apparently design majors perform no better than non-design majors on nearly all of the CDT criteria. Of the two possible interpretations -- (1) design majors are no better creative problem solvers than non-design majors, and (2) the CDT does not measure the creative problem solving skill possessed by design majors -- the latter interpretation is chosen.

Research Question No. 7 - Theory Testing:

What is the relationship between each of the following three variables and performance on the Creative Design Test:

1. Amount of problem-related knowledge possessed. (Data collection form is in Appendix A)

2. Degree of knowledge possessed regarding the criteria for solution originality. (Appendix B)

3. The use of a systematic versus non-systematic problem-solving process. (Appendix C)

Hypothesis: There will be a statistically significant positive correlation between each of the above variables and each of the Creative Design Test criteria.

Statistical Question: What is the correlation between the three variables and the Creative Design Test criteria?

Analysis: Correlation.

Results: There were no statistically significant correlations between the first two variables above (related knowledge and criteria knowledge) and the Creative Design Test criteria; and there was one significant correlation for the third variable: non-systematic problem solving process was correlated with flexibility on the School Pride problem at .37, $p < .02$.

Interpretation:

The most appealing explanation for these results is that the measures of problem-related knowledge, criteria knowledge, and problem-solving process, were invalid. And this seems to be a legitimate position to take in view of the self-report rating scale-type instruments employed to obtain these data. These instruments were chosen because the idea of attempting to collect such data did not emerge until shortly before the data were to be collected, and time did not permit the construction of more desirable instruments.

Of course, it is possible that the instruments are reasonably valid and that little relationship actually exists between what they measure and Creative Design Test performance. But it is considered imperative to explore the above relationships again with well-validated instruments before any firm conclusions can be drawn.

Research Question No. 8 - Experimental Treatment Effects:

Does examining prior solutions of differing degrees of originality and variety influence performance on the Creative Design Test?

Hypothesis: none stated.

Statistical Question: Is there a statistically significant difference between any of the five groups (four treatment and one control) on any of the creative design test criteria scores?

Analysis: Multiple linear regression analysis: Full model = weights for two groups used versus Restricted model = one weight for both groups combined; performed for all paired groups.

Results: The N's, means, and standard deviations for the four treatment groups and the control group are presented in Table 7. The rank order of group means and significant differences between means for each problem and the total Creative Design Test are presented in Table 8.

There were no significant group differences for the fluency criterion, and only one for flexibility -- on the Instruction Time problem -- group 5, the control group, was significantly better than groups 2 and 3. For the originality criterion, group 1 was significantly better than groups 2, 4, and 5 on the Paper Product problem and on the Laundromat problem. On the originality criterion for the total test, groups 1 and 3 were both superior to group 4.

TABLE 7

N's, Means, and Standard Deviations for Design Student Groups on Creative Design Test

TEST	Crit-erion	Grp 1 HV HO*			Grp 2 HV LO			Grp 3 LV LO			Grp 4 LV HO			Grps 1,2,3,4			Grp 5		
		N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Paper Product	Flex	19	5.42	1.18	17	4.88	1.49	12	5.58	.95	14	5.21	.94	62	5.26	1.22	41	4.81	1.25
	Orig	19	7.36	1.25	17	5.06	2.19	12	6.58	1.11	14	5.74	1.95	62	6.21	1.93	41	5.85	2.25
School Pride	Flex	18	5.56	1.21	16	5.13	1.32	11	4.73	1.81	12	5.42	1.38	57	5.24	1.44	38	5.73	1.67
	Orig	18	6.58	2.00	16	5.66	1.70	11	6.83	2.25	12	6.75	1.83	57	6.41	2.00	38	5.94	2.29
Instruc-tion Time	Flu	12	8.67	3.38	12	9.67	5.66	9	7.22	1.40	8	8.00	3.12	41	8.51	3.98	29	10.10	5.16
	Flex	12	3.33	1.03	12	3.00	1.08	9	2.89	.57	8	3.50	.87	41	3.17	.96	29	3.66	.99
	Orig	12	4.90	2.37	12	4.47	2.32	9	3.98	1.97	8	5.23	2.64	41	4.63	2.37	29	5.73	2.28
Laundro-mat	Flu	11	11.33	4.15	9	14.11	11.38	9	11.11	4.10	7	9.43	3.11	36	11.59	6.76	28	13.46	6.54
	Flex	11	4.17	.69	9	4.11	.99	9	4.00	.94	7	4.57	1.11	36	4.20	.94	28	4.43	.98
	Orig	11	6.18	2.36	9	6.49	1.93	9	6.42	2.62	7	5.77	1.98	36	6.34	2.28	28	5.89	2.40
Library Mater-ials	Flu	9	8.00	2.65	9	6.78	4.89	7	7.50	2.55	6	8.00	2.62	31	7.56	3.41	27	8.37	4.75
	Flex	9	6.60	3.85	9	4.44	1.57	7	4.75	1.79	6	5.00	1.07	31	5.27	2.60	27	5.30	2.05
	Orig	9	3.76	2.33	9	3.64	2.00	7	2.94	1.75	6	3.20	1.48	31	3.43	1.99	25	3.58	2.61
Total CDT	Flu	9	29.50	7.09	9	30.89	21.40	7	26.50	7.07	6	24.57	7.63	31	28.15	12.87	25	30.15	12.59
	Flex	9	25.20	5.33	9	22.00	4.30	7	21.88	2.93	6	23.00	4.87	31	23.12	4.70	25	23.32	3.73
	Orig	9	5.90	1.16	9	5.14	1.19	7	5.46	.96	6	4.99	1.42	31	5.42	1.23	25	5.07	1.28

* Prior-solution Treatments: H=High, L=Low, V=Variety, and O=Originality

Table 8

Rank Order of Group Means and Significant Differences Between Means for Each Creative Design Test Problem

Criterion	Rank Order of Group Means 1 2 3 4 5 / Significant Differences between Means	F	Sig.
Paper Product			
Flexibility	3 1 4 2 5 / NSD		
Originality	1 3 5 4 2 / 1> 2	10.87	.001
	1> 4	7.67	.007
	1> 5	6.78	.01
School Pride			
Flexibility	5 1 4 2 3 / NSD		
Originality	3 4 1 5 2 / NSD		
Instruction Time			
Fluency	5 2 1 4 3 / NSD		
Flexibility	5 4 1 2 3 / 5> 3	4.64	.04
	5> 2	3.56	.06
Originality	5 4 1 2 3 / NSD		
Laundromat			
Fluency	2 5 1 3 4 / NSD		
Flexibility	4 5 1 2 3 / NSD		
Originality	2 3 1 5 4 / NSD		
Library Materials			
Fluency	5 1 4 3 2 / NSD		
Flexibility	1 5 4 3 2 / NSD		
Originality	1 2 5 4 3 / NSD		

	CDT Totals						
Fluency	2	5	1	3	4		
	NSD						
Flexibility	1	5	4	2	3		
	NSD						
Originality	1	3	2	5	4		
	1				4	5.41	.02
		3			4	4.00	.05

Interpretation:

It is apparent that little consistency exists among the treatment effects for the five problems. Since the prior-solution treatments are considered adequate expressions of each prior-solution condition (i.e., the number, variety, and originality of prior solutions were adequate), differences in prior-solution conditions, or whether prior solutions are examined or not, does not appear to be powerful enough to permit any specific treatment to be recommended over any other for other than one criterion on one Creative Design Test problem. These findings are consistent with the results of two previous studies: the conflicting effects which Hyman found with homogeneous versus heterogeneous prior solutions for two separate problems (1961) and the lack of effect with common versus unusual prior solutions for two different problems, Hyman (1964).

CHAPTER 4 CONCLUSIONS

The following things were accomplished in this study:

1. A research program in creative problem solving was outlined in which (a) creative problem solving was defined, (b) important assumptions regarding the nature of creative problem solving were specified, (c) a list of variables thought to influence creative performance were specified, and (d) a multivariate research strategy was described.

2. A test of creative problem solving (labelled the Creative Design Test) was developed and the following conclusions are offered based on the data obtained.

   (1) An acceptable scoring reliability was achieved on three of the five problems in the Creative Design Test (Instruction Time, Laundromat, and Library Materials).

   (2) Acceptable interproblem reliabilities were obtained for three of the five problems (Instruction Time, Laundromat, and Library Materials).

   (3) The three criteria measured on the Creative Design Test, fluency, flexibility, and originality, provide similar measures of creative problem solving performance.

   (4) No construct validity was obtained for the Creative Design Test from design instructors' ratings of classroom creativity.

   (5) Some evidence, though meager, of construct validity for the Creative Design Test was found from the relationships with other creativity tests.

   (6) No construct validity was obtained for the Creative Design Test by comparing design students' scores with the scores of education majors.

   (7) No support was obtained for the hypothesis that Creative Design Test performance was related to the amount of problem-related knowledge a student possessed, or that Creative Design Test performance was related to whether a systematic or non-systematic problem solving process was employed.

(8) Variations in the variety and originality of prior solutions examined -- and whether or not prior solutions are examined -- appears to make little difference in performance on the majority of the Creative Design Test problem criteria. The exceptions to this finding are inconsistent, and as a result, the prior solution variables investigated are to be tentatively considered of minor significance as independent variables in creative problem solving.

Based on the results of this study, the following plans have been made for the next phase of the research program.

Two problems in the Creative Design Test will be dropped (Paper Product and School Pride) primarily because of their low scoring reliability and lack of relationship with the other three tests, and the fluency and flexibility criteria will be eliminated from the problem instructions and will not be scored on the other three problems (Instruction Time, Laundromat, and Library Materials). Students will be instructed to produce only five solutions for each problem and to strive only for originality.

Further attempts to obtain construct validity will be made by having design instructors rate the originality of solutions to the Creative Design Test and also by administering the test to a non-university sample to determine whether university-related subject matter of the problems influences performance on the test.

Several instruments will be administered to a sample to determine the amount of variance in Creative Design Test performance accounted for by each test. The instruments to be included will be measures of: Intelligence, critical thinking, personality, short-term memory, problem-related knowledge.

Three variables to be manipulated in future studies include long-term pre-problem experiences such as synectics training or programed instruction in morphological analysis, brainstorming training, and induced incentive for highly original solutions.

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APPENDIX A

Form used to Obtain an Estimate of each Ss' Amount of Problem Related Knowledge

PAPER PRODUCT PROBLEM

Related Knowledge

How much knowledge do you have regarding the various aspects of the problem you just completed? In other words, how familiar are you with the type of problem and with the specific elements involved in the problem?

Place an "X" in the appropriate box on each of the items below.

1. Estimate how much you know about the variety of products which can be made of paper.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

2. Estimate how much you know about the kinds of things SIU students are likely to buy.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

3. Estimate how familiar you are with problems like the paper product problem.

Totally Unfamiliar	Slightly Familiar	Moderately Familiar	More-than-Moderately Familiar	Highly Familiar
☐	☐	☐	☐	☐

SCHOOL PRIDE PROBLEM

Related Knowledge

How much knowledge do you have regarding the various aspects of the problem you just completed? In other words, how familiar are you with the type of problem and with the specific elements involved in the problem?

Place an "X" in the appropriate box on each of the items below.

1. Estimate how much you know about factors which would likely influence how faculty and students feel about SIU.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

2. Estimate how familiar you are with problems like the school pride problem.

Totally Unfamiliar	Slightly Familiar	Moderately Familiar	More-than-Moderately Familiar	Highly Familiar
☐	☐	☐	☐	☐

LAUNDROMAT PROBLEM

Related Knowledge

How much knowledge do you have regarding the various aspects of the problem you just completed? In other words, how familiar are you with the type of problem and with the specific elements involved in the problem?

Place an "X" in the appropriate box on each of the items below.

1. Estimate how much you know about procedures and equipment which might increase the amount of business done by businesses such as laundromats.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

2. Estimate how much you know about the kinds of things which would be likely to appeal to SIU students in laundromats.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

3. Estimate how familiar you are with problems like the Laundromat problem.

Totally Unfamiliar	Slightly Familiar	Moderately Familiar	More-than-Moderately Familiar	Highly Familiar
☐	☐	☐	☐	☐

LIBRARY MATERIALS PROBLEM

Related Knowledge

How much knowledge do you have regarding the various aspects of the problem you just completed? In other words, how familiar are you with the specific elements involved in the problem?

Place an "X" in the appropriate box on each of the items below.

1. Estimate how much you know about procedures for storing and using library materials.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

2. Estimate how much you know about the kinds of preventative measures which would probably be effective with SIU students.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

3. Estimate how familiar you are with problems like the library materials problem.

Totally Unfamiliar	Slightly Familiar	Moderately Familiar	More-than-Moderately Familiar	Highly Familiar
☐	☐	☐	☐	☐

INSTRUCTION TIME PROBLEM

Related Knowledge

How much knowledge do you have regarding the various aspects of the problem you just completed? In other words, how familiar are you with the type of problem and with the specific elements involved in the problem?

Place an "X" in the appropriate box on each of the items below.

1. Estimate how much you know about instruction procedures and equipment which could help solve the instruction time problem.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

2. Estimate how much you know about transportation systems which might be used to solve the problem.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

3. Estimate how much you know about possible architectural solutions.

No Knowledge	A Small Amount of Knowledge	A Moderate Amount of Knowledge	More-than-Average Amount of Knowledge	A Considerable Amount of Knowledge
☐	☐	☐	☐	☐

4. Estimate how familiar you are with problems like the instruction time problem.

Totally Unfamiliar	Slightly Familiar	Moderately Familiar	More-than-Moderately Familiar	Highly Familiar
☐	☐	☐	☐	☐

APPENDIX B

Form used to Assess Ss' Knowledge of Criteria for Solution Originality

CRITERIA KNOWLEDGE

Paper Product Problem

Several solutions to the paper product problem appear below. Indicate on the first scale by each solution how original you think the solution is and indicate on the second scale how well you think the product would sell to S.I.U students.

	Originality	Sales Potential
1. Stationery with SIU letterhead.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐
2. A raffle book with 10¢ chances for free trip to Florida over spring break.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐
3. Confetti for football games.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐
4. Mobile with pictures of SIU officials with funny captions.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐
5. Psychedelic posters.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐
6. An SIU calendar with important events.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐
7. Three-dimensional objects such as piggy-banks, Kleenex box, etc.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐
8. Already-written letters to parents to fit various occasions.	Lo Med Hi ☐ ☐ ☐	Lo Med Hig ☐ ☐ ☐
9. A package of paper airplanes with printed fold-marks.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐
10. Protest pamphlets with blanks to fill in whatever's being protested.	Lo Med Hi ☐ ☐ ☐	Lo Med Hi ☐ ☐ ☐

CRITERIA KNOWLEDGE

School Pride Problem

Several solutions to the school pride problem appear below. Indicate on the scale by each solution how original you think the solution is.

Originality

1. Since pride is often fostered by possession, a student-faculty corporation could be formed. Shares would be sold in the organization; it would be owned by the shareholders. This corporation could function in an advisory capacity to officials of the University. It could use its capital to promote its interests and objectives. — Lo ☐ Med ☐ Hi ☐

2. Offer rewards (monetary) for acts of pride from the President's central account. — Lo ☐ Med ☐ Hi ☐

3. Exhibit of work of three or four top students in each department -- original stories, poems from English Dept., original experiments from science departments, visual work from Art, original plays from Drama, etc. — Lo ☐ Med ☐ Hi ☐

4. Raise entrance requirements. Therefore, the kids that get in will be the ones who are proud to get an education, not the ones who just like college life but could care less about an education. — Lo ☐ Med ☐ Hi ☐

5. Have a Student Appreciation Day where students run the University for one day a year. — Lo ☐ Med ☐ Hi ☐

6. Supplementary forms of fraternities and sororities should be formed with restrictions on class (Fr., Soph., etc.) to make a student want to be one of the above. — Lo ☐ Med ☐ Hi ☐

7. A series of public panel discussions made up of University officials, faculty, and students discussing pride, what the University is, how it runs, how important a part students and faculty play, etc. — Lo ☐ Med ☐ Hi ☐

8. Publicize little-known facts about Southern -- things that are important. Give the students something to be proud of. — Lo ☐ Med ☐ Hi ☐

9. Clean up the University so it deserves respect. Get rid of some of the ugly, old buildings. Clean up some of the mudholes around sidewalks and buildings. Remake broken objects instead of just patching them up.

Lo ☐ Med ☐ Hi ☐

10. The University could sponsor a flag design contest. Once a design is selected, a pledge could be written and forced to be said at the start of every class period. The results would be a "far-right" University -- or universalistic government.

Lo ☐ Med ☐ Hi ☐

CRITERIA KNOWLEDGE

Instruction Time Problem

Several solutions to the instruction time problem appear below. Indicate on the first scale by each solution how original you think the solution is. Indicate on the second scale how effective you think each solution would be.

	Originality	Effectiveness
1. Monorail in major campus areas.	Lo Med Hi	Lo Med Hi
2. Build close-in parking buildings.	Lo Med Hi	Lo Med Hi
3. More independent study -- teachers stay in offices, students in dorms.	Lo Med Hi	Lo Med Hi
4. Take the chains down and let people walk where they need to.	Lo Med Hi	Lo Med Hi
5. Eliminate classrooms and classes and instruct each student via his home television set.	Lo Med Hi	Lo Med Hi
6. Movable sidewalks.	Lo Med Hi	Lo Med Hi
7. Call the library and get the books you want by messenger.	Lo Med Hi	Lo Med Hi
8. Since it easier to move one professor than 20 - 300 students, have more classes in living areas.	Lo Med Hi	Lo Med Hi
9. Everybody run -- both to save time and to keep fit!	Lo Med Hi	Lo Med Hi
10. If places must be so far apart, have a tube which you get sucked into and are sucked to the place you want to go.	Lo Med Hi	Lo Med Hi

CRITERIA KNOWLEDGE

Laundromat Problem

Several solutions to the laundromat problem appear below. Indicate on the scale by each solution how original you think each solution is.

	Originality
1. One addition which I feel would greatly influence the choice would be a TV with all of SIU's lectures at their regular times, also the other three networks.	Lo ☐ Med ☐ Hi ☐
2. Music should be piped in through speakers in the ceiling in restricted areas.	Lo ☐ Med ☐ Hi ☐
3. The Daily Egyptian should be delivered there.	Lo ☐ Med ☐ Hi ☐
4. Showing short movies like Charlie Chaplin, Road Runner, Bogart, etc., something currently in.	Lo ☐ Med ☐ Hi ☐
5. Playboy girls in person.	Lo ☐ Med ☐ Hi ☐
6. Live music and dancing.	Lo ☐ Med ☐ Hi ☐
7. Free typewriters.	Lo ☐ Med ☐ Hi ☐
8. Transportation. Buy a VW Bus $2,000. Free transportation to and from the laundry each Saturday. Bus would follow a certain route and stop at particular corners each hour. $3,000 for salary for one person to drive bus each Saturday and for upkeep and gasoline.	Lo ☐ Med ☐ Hi ☐
9. The possibility of a coin-operated hair dryer could be an asset to business. Women could dry their hair while waiting for clothes.	Lo ☐ Med ☐ Hi ☐
10. Study carrels -- sound-proof.	Lo ☐ Med ☐ Hi ☐

CRITERIA KNOWLEDGE

Library Materials Problem

Several solutions to the library materials problem appear below. Indicate on the first scale by each solution how original you think the solution is. Indicate on the second scale how effective you think each solution would be.

	Originality	Effectiveness
1. The xerox copy service should be encouraged more in the library. Articles, illustrations, etc., copied free for the student, costing the library approximately 5¢ per copy, might prove cheaper in the long run than replacement of expensive reference materials. The service would have to be advertised via signs, and speedy service offered.	Lo ☐ Med ☐ Hi ☐	Lo ☐ Med ☐ Hi ☐
2. An editorial campaign, cartoons, and articles on this problem in the student newspaper emphasizing the harm done to the average student -- less money to buy more books and periodicals, unavailability of materials, etc., could put pressure on students from their peers rather than the library authorities.	Lo ☐ Med ☐ Hi ☐	Lo ☐ Med ☐ Hi ☐
3. Closed stacks -- inspection before and after use.	Lo ☐ Med ☐ Hi ☐	Lo ☐ Med ☐ Hi ☐
4. Wire the book to give a severeelectric shock if they are torn or marked.	Lo ☐ Med ☐ Hi ☐	Lo ☐ Med ☐ Hi ☐
5. Place all reference material on microfilm.	Lo ☐ Med ☐ Hi ☐	Lo ☐ Med ☐ Hi ☐
6. Employ some type of electronic monitoring in reference and periodical sections, such as cameras, mirrors, etc.	Lo ☐ Med ☐ Hi ☐	Lo ☐ Med ☐ Hi ☐
7. Making public the names of people caught abusing materials and stiff penalties, perhaps enforced by a student-type court would be effective.	Lo ☐ Med ☐ Hi ☐	Lo ☐ Med ☐ Hi ☐

8. Floriscope when leaving the library -- library materials all treated with barium.

Lo ☐ Med ☐ Hi ☐ Lo ☐ Med ☐ Hi ☐

9. Use non-tearable paper (nylon?)

Lo ☐ Med ☐ Hi ☐ Lo ☐ Med ☐ Hi ☐

10. Provide duplicate periodicals for check-out just like books. Many students simply don't have time to sit in the library for three hours and copy an article for later reference.

Lo ☐ Med ☐ Hi ☐ Lo ☐ Med ☐ Hi ☐

APPENDIX C

Form used for Ss' to Indicate The Type of Problem Solving Process Employed on each Problem

Problem Solving Process

What kind of problem-solving process did you follow in producing solutions for the problem you just completed? In other words, what kind of thinking process did you use?

____ Check here if you followed a completely non-systematic process in which you tried to think of solutions in a sort of intuitive or random trial-and-error fashion.

____ Check here if you followed some kind of systematic thinking process in producing solutions, and briefly describe as best you can the process you followed.

APPENDIX D

Instructions and Rating Form used To Obtain Design Instructor's Ratings Of Ss Creative Design Performance In Design Courses

M E M O

TO:

FROM: David T. Miles, Educational Research Bureau

DATE:

A number of creativity tests have recently been administered to several design students. One element of information I would like to obtain about these tests is the degree of correlation between the students' creative performance on the tests and their creative performance as design students. The way I intend to do this is have the design faculty estimate the level of each student's scores on the tests with a statistical correlation test.

I am going to ask you to rate each student on two criteria: (1) his level of creative design performance, and (2) his level of overall design performance.

By "creative design performance," I am referring to the originality of a student's ideas or the variety of different ideas a student produces in solving design problems. "Overall design performance" refers to the implementation of ideas, such as the craftmanship of a student's work and other attributes which go to make up design performance in addition to the quality of ideas produced as problem solutions.

Indicate your estimate of the level of Creative Design Performance and the level of Overall Design Performance for each of these students.

	Low	Low Average	Average	High Average	High
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○
Creative Design Performance	○	○	○	○	○
Overall Design Performance	○	○	○	○	○

APPENDIX E

Example of the Form used to Present And Record Evaluations Of Prior Solutions To Each Problem

Name:_____

Previous Solutions for Paper Product Problem

Instructions: In the space provided beneath each of the five solutions listed below briefly specify two or three reasons why each solution is a good one. In other words, point out two or three positive features for each solution.

1. [illegible] a paper lab apron for chemistry students to protect their clothes. It can be taken off quickly if something is spilled on it.

2. Make up a disposable travel kit, including towel, razor, toothbrush, comb --- all made of paper.

3. Print a list of all the general studies courses and some hints on how to avoid some and how to do well in others.

4. Put together a series of "analyze your room-mate" kits, including a set of inkblots and explanations for each.

5. Print each sheet with a geometric design and sell them with a roll of black tape. This is a wallpaper kit. Each piece is put in desired position and taped to the wall.

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OFFICE OF EDUCATION

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TITLE
Development of a Test for an Experimental Research Program in Creative Problem Solving

PERSONAL AUTHOR(S)
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INSTITUTION (SOURCE) Southern Illinois University, Carbondale, Ill., Educational Research Bur. SOURCE CODE

REPORT/SERIES NO.

OTHER SOURCE SOURCE CODE

OTHER REPORT NO.

OTHER SOURCE SOURCE CODE

OTHER REPORT NO.

PUBL. DATE 26-Aug-68 | CONTRACT GRANT NUMBER OEG-3-7-700037-2940

PAGINATION ETC
60 pages

RETRIEVAL TERMS
Creative Problem Solving
Test Development in Creativity and Problem Solving
Research Program in Creativity

IDENTIFIERS

ABSTRACT The purpose of this first phase of a continuing research program was the development of a test of creative problem solving in general design. The major results were:

1. An acceptable scoring and interproblem reliability was achieved on three of the five problems in the Creative Design Test (CDT).
2. No construct validity was obtained from teacher ratings of creative performance in class or from a comparison of design students (the students for whom the tests were designed) and a group of non-design students.
3. Meager evidence of construct validity was obtained from correlations with two of Torrance's tests and four of Guilford's tests.
4. No support was obtained for predicted relationships between performance on the Creative Design Test and (1) amount of problem-related knowledge possessed, and (2) whether systematic or non-systematic problem solving procedures were employed.
5. Variations in the variety and originality of prior solutions examined -- and whether or not prior solutions are examined -- was found to make little difference in performance on the CDT.

Subsequent research will involve (1) further attempts to obtain validity for the three more reliable problems; (2) determination of the relationships between CDT and several other tests; and (3) multivariate experiments with variables which have been shown to have a powerful influence on creative problem solving.